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ALGONQUIN, IL

Assistant Commissioner for Patents
Washington, District of Columbia 20231

jc857 U.S. PTO
09/650496
08/29/00

Sir:

Please file the following enclosed patent application papers:

Applicant #1, Name: Dale E Fiene

Other Applicant(s):

Title: UNDER-CABINET LIGHTING SYSTEM

(X) Specification, Claims, and Abstract: Nr. of Sheets 24
(X) Declaration: Date Signed: 8/29/00
(X) Drawing(s): Number of Sheets Enclosed: (In Triplicate):
 Formal: 5
 Informal: 0
(X) Small Entity Declaration of Inventor(s)
() Small Entity Declaration of Non-Inventor / Assignee/Licensee
() Assignment; please record and return; recordal fee enclosed.
(X) Check for \$ 564 for:
 (X) \$ 564 for filing fee.
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(X) Return Receipt Postcard Addressed to Applicant #1.
(X) Request Under MPEP § 707.07(j): The undersigned, a pro-se applicant, respectfully requests that if the Examiner finds patentable subject matter disclosed in this application, but feels that Applicant's present claims are not entirely suitable, the Examiner draft one or more allowable claims for applicant.

Very respectfully,

Dale E Fiene
Signature

8/29/00
Date

Dale E Fiene
622 Gaslight Drive Algonquin, IL 60102

Fee Transmittal

In the United States Patent and Trademark Office

Mailed 8/29 /2000

Box Patent Application
Assistant Commissioner for Patents
Washington, District of Columbia 20231

Fee Transmittal

First-Named Applicant Dale E. Fiene

Title of Invention: UNDER-CABINET LIGHTING SYSTEM

Total Payment Enclosed (From Calculation Below): \$ 564 (Check)

Sir:

Enclosed is the following small entity filing fee for the above patent application:

Fee Code	Fee Description	Fee (\$)
201	Basic Utility Application Filing Fee	<u>345</u>
		Subtotal (1) \$ <u>345</u>
203	Total Claims: <u>27</u> - 20 = <u>7</u> ; X <u>9</u> (fee for each claim over 20) = \$ <u>63</u>	
202	Independent Claims: <u>7</u> - 3 = <u>4</u> X <u>39</u> (fee for # of independent claims > 3) = \$ <u>156</u>	
		Subtotal (2) \$ <u>219</u>
	Total Payment Enclosed [Sum of Subtotals (1) and (2)]	\$ <u>564</u>

Very respectfully,

Signature of First-Named Applicant Dale E. Fiene

Print Name of First-Named Applicant Dale E. Fiene

In the United States Patent and Trademark Office

First/Sole Applicant: Dale E Fiene

Other Applicant(s):

Title: "UNDER-CABINET LIGHTING SYSTEM"

Small Entity Declaration - Independent Inventor(s)

As a below-named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9(c) for purposes of paying reduced fees under Section 41(a) and (b) of Title 35 United States Code, to the Patent and Trademark Office with regard to my above-identified invention described in the specification filed herewith. I have not assigned, granted, conveyed, or licensed and am under no obligation under any contract or law to assign, grant, convey, or license any rights in the invention to either (a) any person who could not be classified as an independent inventor under 37 CFR 1.9(c) if that person had made the invention, or (b) any concern which would not qualify as either (i) a small business concern under 37 CFR 1.9(d) or (ii) a nonprofit organization under 37 CFR 1.9(e).

Each person, concern, or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

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I acknowledge a duty to file, in the above application for patent, notification of any change in status resu CFR 1.28(b)).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Dale E Fiene
Signature

8/28/00
Date

Dale E Fiene
622 Gaslight Drive, Algonquin, IL 60102

Patent Application of Dale E Fiene

for

Under-cabinet Lighting System

BACKGROUND -- Field of Invention

This invention relates to gas discharge lamp luminaires in general, and to gas discharge lamp luminaires for under-cabinet type lighting in particular.

BACKGROUND - Description of Prior Art

Current fluorescent luminaires for under-cabinet applications typically consist of a plastic or metal enclosure which contain a fluorescent lamp ballast, wiring to lampholders, lampholders, one or more fluorescent lamps, and a lens. The fluorescent lamp ballast, wiring to lampholders and the back part of the lampholders are contained in one compartment of the enclosure. This part of the enclosure also contains the connection of the wiring from the 60-Hertz power source to the input of the fluorescent lamp ballast. A less common arrangement is to place the 60-Hertz fluorescent lamp ballast in a “remote ballast enclosure” and connect the “remote ballast enclosure” to the balance of the luminaire by way of a BX cable. In both cases, the size of the enclosure is substantial compared to the size of the fluorescent lamps themselves. This is because the fluorescent lamp ballast is powered from a 60-Hertz source, which results in a physically large package. Using an electronic ballast generally contributes to a significant weight reduction, assuming the ballast is not potted with asphalt, but the physical size is usually not dramatically reduced. The connection from the 60 Hertz source to the fluorescent lamp ballast has to be made in an enclosure that meets specific requirements dictated by Underwriters Laboratories’ STANDARD FOR FLUORESCENT LIGHTING FIXTURES (UL1570); therefore, the enclosure is much larger, heavier and more expensive than it might otherwise need to be. Nilssen discloses the use of high-frequency power limited voltage to power fluorescent lamps in a number of his patents. In fig. 14 of U.S. patent 5,640,069; Nilssen discloses an under-cabinet lighting system where a number of lamp structures are plugged into one another by connecting the male-type input port of one lamp structure into the female-type output port of the preceding lamp structure. As shown in fig. 14 of the Nilssen patent, this is accomplished by plugging the

male-type-input port directly into the female-type output port. This approach works well for designs that use linear lamps and where a continuous line of light is desired. This approach does not work at all for single-ended lamps. That same figure also shows an alternate approach, which is implemented by making this connection with a short interconnecting cord. Although adding some flexibility when used in combination with the previous approach it requires that a wide selection of lengths of previously manufactured interconnecting cords be stocked and available or that the various lengths of cords need to be made up at the time of installation. If the interconnecting cords are used under a wall cabinet, a relatively large hole needs to be drilled between the lower portion of the adjacent sides of the wall cabinets to accommodate the connectors on the interconnecting cords, which are significantly larger than the cord itself.

Objects and Advantages

Accordingly, several objects and advantages of my invention are a simpler and more flexible system for installing and connecting under-cabinet type lighting plus a self-contained one-piece ballasted-socket assembly for single-ended lamps that can be mounted directly beneath a cabinet or a shelf. The unit is much lighter and more compact than existing under-cabinet fixtures currently available and it allows for a number of luminaires to be connected along the same high-frequency power cord without the need for providing separate male and female connectors on the power cord or in the luminaires.

Still further objects and advantages will become apparent from a consideration of the ensuing description and accompanying drawings.

Brief Description of the Drawings

Fig. 1 shows a view of the underside of a kitchen wall cabinet and the basic components of the under-cabinet lighting system;

Fig. 2 shows a more detailed view of a high-frequency ballasted-socket assembly shown in Fig.1;

Fig. 3 shows a two-lamp ballasted-socket assembly for under-cabinet lighting using two double Biax lamps;

Fig. 4 shows a ballasted-socket assembly applied to a single long Biax lamp;

Fig. 5 schematically shows a typical one-lamp ballasted-socket assembly circuit;

Fig. 6 schematically shows a typical two-lamp ballasted-socket assembly circuit.

Reference Numerals

1	10 wall cabinet	26	60 base cover plate
2	12 wall cabinet bottom	27	62 double Biax lamp
3	14 high-frequency power supply	28	64 mounting base
4	16 duplex wall outlet	29	66 ballast housing
5	18 high-frequency output cord	30	68 Biax lamp ballasted-socket assembly
6	20 access hole	31	70 long Biax lamp
7	22 cabinet side panels	32	72 Biax lamp socket
8	24 high-frequency ballasted-socket assembly	33	74 support bracket
9	26 slide-on cover	34	76 recess
10	28 2D lamp	35	78 transformer
11	30 recessed channel	36	80 cathode windings
12	32 reflector	37	82 ballasting capacitor
13	34 high-frequency input terminal #1	38	84 power level jack
14	36 high-frequency input terminal #2	39	86 power level plug
15	38 base	40	87 gas discharge lamp
16	40 base tabs	41	88 output terminals
17	42 column	42	89 cathode
18	44 four-pin lamp socket	43	90 power increasing capacitor
19	46 lamp plug assembly	44	91 cathode terminal
20	48 cover tabs	45	92 tank capacitor
21	50 center ridge	46	94 tank inductor
22	52 screw holes	47	96 starting aid capacitor
23	54 two lamp high-frequency ballasted-socket assembly	48	98 supplemental ballasting capacitor
24	56 recessed channel A	49	100 three-terminal socket
25	58 recessed channel B	50	102 power level jumper

1 **SUMMARY**

2

3 This invention is directed to a design of an under-cabinet type lighting system. The
4 system is comprised of a high-frequency power source, an interconnecting power cord, and one
5 or more self-contained one-piece ballasted-socket assemblies for single-ended lamps. The high-
6 frequency power source is connected to a 50 or 60 Hertz power line. An interconnecting power
7 cord is connected to the output of the high-frequency power source and routed beneath the
8 cabinets or shelves. In one embodiment, the ballasted-socket assemblies are then mounted
9 directly beneath the cabinets or shelves. The interconnecting power cord is then placed into a
10 recessed channel built into the ballasted-socket luminaire and a cover is slid over the channel
11 forcing the cord down and into a pair of input terminals that make electrical contact with the
12 conductors within the interconnecting cord. A number of additional ballasted-socket assemblies
13 can be added at any point along the length of the interconnecting power cord up to the maximum
14 power rating of the high-frequency power source.

15

16

17 **DESCRIPTION - Preferred Embodiment**

18

19 Fig. 1 shows a view of the underside of a kitchen wall cabinet 10. As shown in the
20 drawing the front, sides, and back of the cabinet actually extend 1.5 to 2 inches below the wall
21 cabinet bottom 12. A high-frequency power supply 14 is shown plugged into a duplex wall outlet
22 16. A high-frequency output cord 18 extends from the high-frequency power supply 14 through
23 access holes 20 that are drilled through the cabinet side panels 22. Beneath the cabinet is shown
24 high-frequency ballasted-socket assembly 24 with slide-on cover 26 and 2D lamp 28. An
25 optional reflector 32 can be installed between the wall cabinet bottom 12 and the high-frequency
26 ballasted-socket assembly 24.

27

28 Fig. 2 shows a more detailed view of the high-frequency ballasted-socket assembly 24
29 shown in Fig.1. In the base 38 of the high-frequency ballasted-socket, assembly 24 is a recessed
30 channel 30. The recessed channel 30 contains high-frequency input terminal #1 34 and high-
31 frequency input terminal #2 36. The two high-frequency input terminals are located in opposite

1 lanes within the recessed channel 30 and protrude approximately 1/16 to 1/8 of an inch above the
2 bottom of the channel. Above the top surface of and on alternate side of the recessed channel 30
3 protrude a pair of base tabs 40. Extending down from the base 38 is a column 42, which along
4 with the base 38 contains ballasting circuitry such as that shown in fig. 5. The column 42 also
5 includes a four-pin lamp socket 44. Incorporated into the four-pin lamp socket 44 are a pair of
6 recesses (not shown), which are engaged by a pair of support tabs (also not shown) built into the
7 base of the 2D lamp plug assembly 46 of the 2D lamp 28. A pair of screw holes 52 is provided
8 on alternate side of column 42 through base 38. The slide-on cover 26 includes a pair of cover
9 tabs 48 on alternate sides of the slide-on cover, which are designed to engage with the base tabs
10 40. In the center of the slide-on cover 26 is a center ridge 50. The center ridge 50 extends the
11 length of the slide-on cover approximately 1/8 of an inch above the inside surface. Each end
12 tapers down to being flush with the inside surface starting approximately 1/8 inch in from each
13 end.

14

15 Fig. 3 shows a two-lamp ballasted-socket assembly 54 for under-cabinet lighting shown
16 with two double Biax lamps 62. The mounting base 64 contains four screw holes 52 and a
17 recessed channel A 56 and a recessed channel B 58 intersecting at right angles. In the area
18 common to recessed channel A 56 and recessed channel B 58 are two conductive input terminals,
19 high-frequency input terminal #1 34 and high-frequency input terminal #2 36. The terminals are
20 offset from one another, such that, if the two intersecting channels are thought of as two lane
21 highways each of the two terminals is in the opposite lane of each of the respective channels. The
22 ballast housing 66 extends down from the mounting base 64 and encloses the high-frequency
23 ballasting circuitry (not visible in this figure, but shown schematically in fig. 6). Incorporated
24 into the ballast housing are two four-pin lamp sockets 44. The four-pin lamp sockets 44 are
25 capable of receiving and supporting a double Biax lamp 62. The base cover plate 60 contains
26 four screw holes 52. It may be desirable to provide matching recesses in the base cover plate 60
27 to aid assembly.

28

29 Fig. 4 shows a Biax lamp ballasted-socket assembly 68 shown with a long Biax lamp 70.
30 As in the previous example the mounting base 64 contains four screw holes 52 and a recessed

1 channel A 56 and a recessed channel B 58 intersecting at right angles. In the area common to
2 recessed channel A 56 and recessed channel B 58 are two conductive input terminals, high-
3 frequency input terminal #1 34 and high-frequency input terminal #2 36. The terminals are offset
4 from one another as described above. The ballast housing 66 extends down from the mounting
5 base 64 and encloses the high-frequency ballasting circuitry (not visible in this figure, but shown
6 schematically in fig. 5). Incorporated into the ballast housing is a long Biax lamp socket 72. The
7 Biax lamp socket 72 is capable of receiving and supporting one end of a Biax lamp 70. Due to
8 the length and weight of a long Biax lamp, an additional support bracket 74 is required to hold
9 the far end of the lamp in place. The support bracket 74 is provided with recess 76. The base
10 cover plate 60 contains four screw holes 52.

11

12 Fig. 5 schematically shows a typical single-lamp ballasted-socket circuit for under-
13 cabinet lighting. The high-frequency input terminal #1 34 and high-frequency input terminal #2
14 36 are provided for connection to high-frequency output cord 18 shown in fig.1. The output
15 terminals 88 are part of the four-pin lamp socket 44 of fig.2 or long Biax lamp socket 72 of fig.
16 4. The output terminals 88 provide voltage to heat lamp cathodes and current-limited voltage to
17 provide lamp current. Transformer 78 is used to step-up or step-down the lamp starting voltage
18 as required by the particular lamp to be used and to supply cathode voltage from the cathode
19 windings 80. Primary ballasting capacitor 82 limits the current supplied to the lamp after lamp
20 ignition. Tank capacitor 92 and tank inductor 94, in concert with the reflected load and primary
21 ballasting capacitor 82, form a parallel resonant tuned circuit. Across primary ballast capacitor
22 82 may be connected an optional power level jack 84 with terminals 84a and 84b. Power level
23 plug 86 is an insulated module containing power-increasing capacitor 90 and having two
24 parallel-elongated terminals 86a and 86b projecting from it. Gas discharge lamp 87 has two
25 cathodes 89. Each of the cathodes has one or more cathode terminals 91.

26

27 Fig. 6 schematically shows a typical circuit for a ballasted-socket for two lamps as is
28 shown in fig. 3. The high-frequency input terminal #1 34 and high-frequency input terminal #2
29 36 are provided for connection to high-frequency output cord 18 shown in fig.1. The output
30 terminals 88 are part of the two separate four-pin lamp sockets 44. The output terminals 88

1 provide voltage to heat lamp cathodes and current-limited voltage to provide lamp current.
2 Transformer 78 is used to step-up or step-down the lamp starting voltage as required by the
3 particular lamp to be used. Transformer 78 also supplies cathode voltage from the three cathode
4 windings 80 and 80a. A starting aid capacitor 96 can be provided between the isolated cathode
5 winding and one of the other cathode windings. Primary ballasting capacitor 82 limits the current
6 supplied to the lamps after lamp ignition. Tank capacitor 92 and tank inductor 94, in concert with
7 the reflected load and primary ballasting capacitor 82, form a parallel resonant tuned circuit. An
8 optional supplemental ballasting capacitor 98 can be provided in series with the primary
9 ballasting capacitor 82. If so provided, a three-terminal socket 100 is also provided as shown in
10 the schematic. Terminal 100b is connected to the junction of primary ballasting capacitor 82 and
11 supplemental ballasting capacitor 98. Socket terminal 100a is connected to the opposite end of
12 primary ballasting capacitor 82 and socket terminal 100c is connected to the opposite end of
13 supplemental capacitor 98. The socket terminal 100a is spaced the same distance from 100b as
14 100c is spaced from 100b. Power level jumper 102 is an insulated plug arrangement with two
15 parallel-elongated terminals suitable for insertion into either socket terminals 100a and 100b or
16 socket terminals 100b and 100c. The pair of gas discharge lamps 87 each has two cathodes 89.
17 Each of the cathodes has one or more cathode terminals 91.

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1 **OPERATION - Preferred Embodiment**

2

3 As shown in fig.1 the bottom 12 of kitchen wall cabinets 10 are actually located 1.5
4 to 2 inches above the bottom edge of the front, rear, and sides of the cabinet. This provides an
5 ideal location to hide lighting to illuminate the kitchen counter top. Unfortunately, the side walls
6 of the cabinets also extend below this bottom. To install lighting under these cabinets it becomes
7 necessary to either cut out sections of the cabinet side panels 22 to create a means to interconnect
8 the lighting fixtures or drill relatively large holes through these side panels to run conduit, BX, or
9 to feed the connector of an interconnecting cord set through. The instant invention permits a
10 much smaller hole to be used to provide wiring access between the individual wall cabinet
11 bottoms for installing the under-cabinet lighting as well as eliminating plugs and or sockets on
12 the luminaires as well as on the interconnecting cords.

13 Referring to fig.1, in the preferred embodiment, a high-frequency power supply 14 is
14 plugged directly into a standard duplex wall outlet 16. The high-frequency output voltage is
15 sinusoidal and may be any voltage up to approximately 150 Volts. Using a voltage of 150 volts
16 has the advantage of minimizing the effect of contact resistance, and it also permits a smaller
17 conductor to be used, but lower voltages could be used if shock hazard is a consideration. Access
18 holes 20 are drilled through the cabinet side panels 22 as close to the wall cabinet bottom 12 as
19 possible. These access holes 20 can be less than a quarter of an inch in diameter. The high-
20 frequency output cord 18 is then fed through the access holes 20 to each wall cabinet bottom 12
21 requiring lighting. A high-frequency ballasted-socket assembly 24 is then mounted to the wall
22 cabinet bottom 12, such that, the recessed channel 30 is in line with the high-frequency output
23 cord. The high-frequency output cord 18 is placed into the recessed channel 30 of the high-
24 frequency ballasted-socket assembly 24. The slide-on cover 26 slides over the recessed channel
25 30 forcing the high-frequency output cord 18 down into the recessed channel 30, and onto a pair
26 of high-frequency input terminals 34 and 36 which are shown in more detail in fig.2. A gas
27 discharge lamp, such as, a 2D lamp 28 is then inserted into the high-frequency ballasted-socket
28 assembly 24.

29 To improve the overall efficacy of the lighting system an optional reflector 32 can be
30 provided. The reflector can be as simple as a flat sheet of reflective plastic or metal, or a molded

1 or fabricated piece including bends or ribs to improve rigidity and to attempt to focus and direct
2 the light. In any case the reflector 32 can simply be mounted by placing it on the wall cabinet
3 bottom 12, mounting the high-frequency ballasted-socket assembly beneath it, and then fastening
4 the combination to the bottom of the wall cabinet bottom 12 with screws inserted through the
5 screw holes 52 provided in both the high-frequency ballasted-socket assembly 24 and the
6 reflector 32. Alternately the reflector 32 can be incorporated as part of the high-frequency
7 ballasted-socket assembly 24. As a third alternate design the reflector 32 can include an aperture
8 between the two screw holes 52 large enough to pass over the column 42 and be mounted
9 between the lamp 28 and the high-frequency ballasted-socket assembly 24.

10 Although the high-frequency power supply 14 is shown as an assembly that is
11 plugged directly into a duplex outlet 16, another design incorporates a line cord emanating from
12 one side of an enclosure and the high frequency output cord emanating from another side. The
13 enclosure is then mounted to the wall cabinet bottom 12. The lights may be turned on and off
14 with a switch incorporated into the high-frequency power supply 14 or via a switch incorporated
15 into the plug of the line cord.

16

17 Fig 3 shows a two-lamp high-frequency ballasted-socket assembly 54. In the basic
18 embodiment shown, the assembly is installed by first locating the base cover plate 60 on the wall
19 cabinet bottom 12 (fig.1). The high-frequency output cord is then passed over the base cover
20 plate. A decision is then made, depending on the application, as to whether the lamps should be
21 oriented such that they are parallel to the high-frequency output cord 18 or perpendicular to it.
22 The two-lamp high-frequency ballasted-socket assembly 54 is then placed over the high-
23 frequency output cord 18, routing the cord through recessed channel A 56 or recessed channel B
24 58. Appropriate size screws are then inserted through the screw holes 52 of both the high-
25 frequency ballasted-socket assembly 54 and base cover plate 60. As the screws are tightened
26 down the high-frequency input terminals #1 and #2 (34 and 36) are forced into high-frequency
27 output cord 18 (fig. 1) and make electrical connection to the appropriate conductors within the
28 cord. Fig. 3 shows a two-lamp high-frequency ballasted-socket assembly with double Biax
29 lamps. This assembly can be configured to also operate as a single lamp high-frequency
30 ballasted-socket assembly as well as be adapted to handle a variety of gas discharge lamp types.

1
2 Fig. 4 shows a Biax-lamp ballasted-socket assembly 68 with a long Biax lamp 70.
3 Shorter varieties of gas discharge lamps, such as, compact fluorescent Biax types can be totally
4 supported by the socket that they are plugged into. Due to the length of the long Biax category of
5 lamps, the lamps cannot be cantilevered out from the socket, but require an additional support
6 element to support the end of the lamp opposite the connector. The support bracket 74 is
7 provided to accomplish this function. The installation of the Biax lamp ballasted-socket
8 assembly is essentially the same as discussed previously regarding the high-frequency ballasted-
9 socket assembly shown in fig. 3 except the support bracket 74 must also be mounted. Here again
10 the Biax-lamp ballasted-socket assembly 68 can be mounted in one of four possible orientations
11 depending on the application. The lamp can be oriented parallel to the high-frequency output
12 cord or perpendicular to it. If the lamp is oriented parallel to the cord, a recess 76 is provided in
13 the support bracket 74 to allow the high-frequency output cord to pass through and act as a
14 support for the cord.
15

16 Fig. 5 is typical of a circuit, which can be used in a ballasted-socket assembly for
17 under-cabinet lighting. In a preferred embodiment, the circuit is designed to be powered from a
18 class II or class III power-limited supply. As a result, the National Electrical Code does not
19 require the interconnecting wires between the power supply and the ballasted-socket assembly to
20 be run in conduit or BX even if the wiring is run within a wall, but permits much lighter weight
21 non-armored cable to be used. In application where the wiring for the under-cabinet lighting is
22 totally exposed (i.e., not run in the wall or behind a cabinet) there is no requirement for the
23 source of power to be restricted to class II or class III source. In order to minimize the physical
24 size of the electronic components used for the ballast circuitry (tank capacitor 92, tank inductor
25 94, ballasting capacitor 82, and transformer 78), operating at a frequency in the range of 18 kHz
26 to 100 kHz is preferred. The cathode windings 80 provide voltage to heat the lamp cathodes for
27 rapid start operation. Ballasting capacitor 82 is connected in series with transformer 78 to limit
28 the current supplied through the gas discharge lamp 87 connected with the output terminals 88.

29 By placing the ballasting capacitor in series with the input side of the transformer 78,
30 the voltage across the input to the transformer 78 is reduced after the gas discharge lamp is

1 ignited and begins to draw current through the lamp, in addition to the current being drawn by
2 the cathodes of the gas discharge lamp. This is due to the fact that a portion of the voltage
3 supplied across the two high-frequency input terminals #1 and #2 (34 and 36) is dropped across
4 the ballasting capacitor. As a result of the voltage being reduced to the input of the transformer,
5 the voltage supplied across the cathodes of the gas discharge lamp is also reduced. This causes a
6 reduction in the power dissipated in the cathodes during normal operation, which allows for
7 increased efficiency of operation. By eliminating the cathode windings 80 and increasing the
8 open circuit output voltage delivered across the lamp, instant start operation of the gas discharge
9 lamp can also be achieved.

10 An optional power level jack 84 can be incorporated by connecting its' two terminals 84a
11 and 84b on alternate ends of ballasting capacitor 82. A power level plug 86 containing power
12 increasing capacitor 90 can be plugged into power level jack 84 on ballasted-socket assemblies
13 where the light level of the gas discharge lamp needs to be increased. Placing the power
14 increasing capacitor 90 in parallel with the ballasting capacitor 82 decreases the impedance in
15 series with the input to the input of transformer 78, which results in an increased lamp current
16 through the gas discharge lamp and an increase in light output. A variety of power level plugs
17 with various values of power increasing capacitors 90 can be made available to provide
18 numerous power levels. Since the power level can only be increased using this approach, the
19 minimum power level is established by ballasting capacitor 82.

20 Tank capacitor 92 and tank inductor 94, in concert with the reflected load and primary
21 ballasting capacitor 82, form a parallel resonant tuned circuit which is set-up to match the
22 fundamental frequency of the high-frequency power supply. By tuning the ballasted-socket
23 assembly in this manner, the power factor of the ballasted-socket assembly can be made to
24 approach unity.

25
26 Fig. 6 is typical of a circuit, which can be used in a two-lamp ballasted-socket assembly
27 for under-cabinet lighting. This circuit operates the same as the circuit in fig. 5 except that an
28 alternate approach is shown for selecting the power level and the circuit is set up for rapid start
29 operation of two lamps in series. Two four-pin lamp sockets 44 are provided for connecting to
30 two separate gas discharge lamps 87. An additional isolated cathode winding 80a provides

1 cathode voltage to the two cathodes (one from each lamp) which end up being connected in
2 parallel via output terminals 88a and 88b. Since the two lamps are connected in series, the same
3 current flows through both lamps, except for the small current, which flows through the starting
4 aid capacitor 96 connected in parallel with one of the lamps. The starting aid capacitor permits
5 the pair of lamps to start with a voltage substantially less than twice that required to ignite a
6 single lamp.

7 If power level selection is desired, a supplemental ballasting capacitor 98 is added in
8 series with ballasting capacitor 82. A three-terminal socket 100 is connected across the two
9 capacitors 82 and 98, such that, terminal 100b is connected to the junction of ballasting capacitor
10 82 and supplemental ballasting capacitor 98. Terminal 100a is connected to the other end of
11 ballasting capacitor 82 and 100c is connected to the other end of supplemental ballasting
12 capacitor 98. If the value ballasting capacitor 82 is chosen to provide the proper nominal light
13 output from the gas discharge lamp and the value of supplemental ballasting capacitor 98 is
14 chosen to be less than the value of ballasting capacitor 82, three levels of light are available. To
15 set the light level at the nominal level the power level jumper is inserted between socket
16 terminals 100b and 100c. A lower light level is selected by inserting the power level plug into
17 terminals 100a and 100b. The lowest light level is selected by leaving the power level jumper out
18 completely.

19 Alternately, if the value ballasting capacitor 82 is chosen to provide the proper nominal
20 light output from the gas discharge lamp and the value of supplemental ballasting capacitor 98 is
21 chosen to be greater than the value of ballasting capacitor 82, three levels of light are also
22 available. To set the light level at the nominal level the power level jumper is again inserted
23 between socket terminals 100b and 100c. A higher light level is selected by inserting the power
24 level plug into socket terminals 100a and 100b. The lowest light level is selected by leaving the
25 power level jumper out completely.

26 Since the power level selection is accomplished on the input to the transformer in both
27 fig. 5 and fig. 6, the cathode voltage is also affected by changing the power level of the lamps.
28 Since lamp life can be adversely affected by reducing the cathode voltage excessively at the
29 same time the lamp current is reduced for dimming, the range of dimming is somewhat limited
30 unless the cathodes are provided with somewhat higher voltage for nominal operation. This

1 limitation can be eliminated by moving the power level selection circuitry and ballasting
2 capacitor to their traditional location, which is in series with the output of the transformer instead
3 of in series with the input to the transformer. This will eliminate the reduction of cathode voltage
4 as a function of the lamp current level (dimming) and permit a much greater dimming range
5 without adversely affecting the life of the lamps.

6

1 **Conclusions, Ramifications, and Scope**

2

3 Accordingly, it can be seen that the invention provides a dramatic reduction in the cost to
4 manufacture, ship and store luminaires. In addition, substantial savings in the cost of installation
5 are achieved since the luminaires can easily be assembled, installed and connected to the power
6 source by non-skilled, non-electrician installers.

7 Although the description above contains many specificities, these should not be construed
8 as limiting the scope of the invention but as merely providing illustrations of some of the
9 presently preferred embodiments of this invention. Various other embodiments and ramifications
10 are possible within it's scope. For example, although the preferred embodiment describes the
11 Under-cabinet Lighting System with a ballasted-socket designed for a class II or class III high-
12 frequency power input, the Under-cabinet Lighting System concept can also be used with non-
13 class II or III, AC and DC circuits. The ballasted-socket in these situations would merely have to
14 enclose all non-class II and III circuits and wiring, while the input connection would have to
15 meet the local codes that may apply. In the preferred embodiment, the enclosure of the ballasted-
16 socket assemblies are constructed out of non-conductive material, which eliminates the need to
17 carry a ground wire in the interconnecting cord, but they could also be made out of conductive
18 material if the exposed conductive material is grounded.

19 Thus, the scope of the invention should be determined by the appended claims and their
20 legal equivalents, rather than by the examples given.

1 **Definitions**

2

3 luminaire: a complete lighting unit consisting of a lamp or lamps together with the parts
4 designed to distribute the light, to position and protect the lamps, and to connect and
5 interface the lamps to the power source.

6

7 compact fluorescent lamps: single-ended fluorescent lamps such as, Biax, double Biax,
8 triple Biax, quad Biax, long Biax, flat, helical, spring, etc.

9

10 high-frequency: frequencies greater than 10 kHz.

11

12 insulation displacement connection: an electrical connection technique in which an
13 insulated wire is inserted into an opening of a connector. A metal terminal is forced
14 through the insulation thus displacing the insulation and forming an electrical
15 connection between the terminal and the conductor.

Under-cabinet Lighting System

CLAIMS

I claim:

1. A system comprising:

a source of high-frequency power having a high-frequency output.

an interconnecting cord comprising a pair of parallel output conductors encased in a common insulating sheath;

said interconnecting cord being connected to the high-frequency output;

a luminaire;

the luminaire having a pair of input terminals, a high-frequency ballasting circuit, and a lamp socket capable of receiving and supporting a lamp;

said pair of input terminals being capable of piercing said common insulting sheath of the pair of parallel output conductors during the installation process of the luminaire, each input terminal making electrical contact with a different conductor.

2. The system described in claim 1 wherein the luminaire can be installed at any location, along the length of the pair of parallel output conductors.

3. The system described in claim 1 wherein multiple luminaires can be installed at any location, along the length of the pair of parallel output conductors.

4. The system described in claim 1, wherein the maximum voltage between the pair of parallel output conductors and the maximum power available from the pair of parallel output conductors meets the limits for Class II or III wiring, as defined by the National Electrical Code.

5. The system described in claim 1, wherein the luminaire can be connected to the pair of parallel output conductors in any one of four possible orientations relative to the pair of parallel

1 output conductors.

2

3 6. The system described in claim 1, wherein a power level selection capability is included;
4 the power level of the luminaire being selected by inserting or moving the location of a
5 plug assembly.

6

7 7. A luminaire suitable for connection to and being powered from a high-frequency power
8 source;

9 the luminaire having a pair of input terminals;
10 the input terminals being located within a channel;
11 the channel being of such a design as to a receive an interconnecting cord comprising two
12 parallel conductors encased within and separated from each other by a common
13 insulating sheath.

14

15 8. The luminaire described in claim 7, wherein the luminaire can be mounted in place prior being
16 connected to the interconnecting cord.

17

18 9. The luminaire described in claim 7, wherein the interconnecting cord is installed in place
19 under the cabinet or shelf before the luminaire is mounted in place under the cabinet or
20 shelf.

21 10. The luminaire described in claim 7, wherein the power factor of the power being drawn by
22 the luminaire is greater than 80%.

23

24 11. The luminaire described in claim 7, wherein the luminaire includes two lamp sockets;
25 the lamp sockets each having a receptacle capable of receiving a single ended lamp;
26 said receptacles facing opposing directions and also located on substantially the same
27 axis.

28

29 12. The luminaire described in claim 7, wherein the luminaire includes an enclosure;
30 said enclosure being non-conductive.

1
2 13. The luminaire described in claim 7, wherein the luminaire is provided with a socket capable
3 of receiving and supporting a long single-ended lamp;
4 said luminaire requiring a support bracket to properly support the long single-ended
5 lamp;
6 said support bracket being provided with a recess capable of allowing said
7 interconnecting cord to pass through.

8
9 14. A luminaire suitable for connection to and being powered from a high-frequency power
10 source by way of an interconnecting cord;
11 the interconnecting cord comprising a first electrical conductor and a second electrical conductor
12 encased within and separated from one another by a common insulating sheath;
13 the luminaire including two channels intersecting at right angles;
14 either channel being capable of receiving said interconnecting cord;
15 the luminaire also including a first input terminal and a second input terminal;
16 the input terminals being designed to pierce the insulation of the interconnecting cord;
17 the input terminals being located within the area of the intersection of the two channels and
18 positioned, such that, the first input terminal making contact with a first electrical
19 conductor and the second input terminal making contact with the second electrical
20 conductor during the installation of the luminaire no matter through which channel the
21 electrical cord is routed.

22
23 15. The luminaire described in claim 14, wherein the luminaire can be mounted in place prior to
24 the insertion of the interconnecting cord.

25
26 16. The luminaire described in claim 14, wherein the interconnecting cord is installed in place
27 under the cabinet or shelf before the luminaire is mounted in place under the cabinet or
28 shelf.

29
30 17. The luminaire described in claim 14, wherein multiple luminaires can be connected to the

1 same interconnecting cord.

2

3 18. The luminaire described in claim 14, wherein the luminaire can be connected to the
4 interconnecting cord in any one of four possible orientations.

5

6 19. The luminaire described in claim 14, wherein the input terminals have a circular or oval
7 cross-section.

8

9 20. A ballasted-socket assembly for installation under a cabinet or shelf;
10 said ballasted-socket assembly including a pair of high-frequency input terminals, a high-
11 frequency ballasting circuit, a lamp socket for a single-ended lamp and an enclosure;
12 said enclosure completely enclosing the high-frequency ballasting circuitry, the interconnecting
13 wiring between the high-frequency input terminals and the high-frequency ballasting
14 circuit, and the interconnecting wiring between the high-frequency ballasting circuit and
15 the lamp socket for a single-ended lamp.

16

17 21. The ballasted-socket assembly described in claim 20 wherein, said enclosure also includes a
18 mounting tab;

19 said mounting tab having holes capable of receiving screws for mounting the ballasted-socket
20 assembly directly to the underside of a cabinet or shelf.

21

22 22. The ballasted-socket assembly described in claim 20, wherein an optional reflector is used
23 with the ballasted-socket assembly;
24 said reflector being installed between the ballasted-socket assembly and the underside of the
25 cabinet or shelf.

26

27 23. An arrangement comprising: a pair of input terminals, a ballasting circuit, a socket with
28 output terminals that is capable of receiving, supporting and making electrical connection
29 to a single-ended lamp, and an enclosure;
30 the input to the ballasting circuit being connected to the pair of input terminals;

1 the output of the ballasting circuit being connected to the output terminals within the socket;
2 the ballasting circuit being capable of properly igniting and powering a gas discharge lamp when
3 provided with a high-frequency voltage on the pair of input terminals;
4 the enclosure completely encapsulating the ballasting circuitry, the interconnection between the
5 input terminals and the ballasting circuitry, the interconnection between the ballasting
6 circuitry and the output terminals of the socket, and the portion of the output terminals to
7 which the ballasting circuitry connects.

8

9 24. The arrangement described in 23, wherein the pair of input terminals makes connection to a
10 source of high-frequency voltage by way of an insulation-displacement connector.

11

12 25. The arrangement described in 23 wherein the wire can be run through the insulation-
13 displacement connector in any one of four possible orientations.

14

15 26. A high-frequency under-cabinet lighting system comprising: a high-frequency power source,
16 an interconnecting cable, and multiple luminaires;
17 the interconnecting cable being supplied with no luminaires connected there to;
18 the system further characterized in that multiple luminaires can be powered from the same
19 interconnecting cable without cutting the interconnecting cable.

20

21 27. A high-frequency ballasting circuit comprising: a pair of input terminals, a capacitor, a
22 transformer, and an inductor;
23 the transformer having a primary winding, multiple low voltage secondary windings and
24 a high voltage secondary windings;
25 the capacitor being connected in series between one of the input terminals and the
26 primary winding of the transformer;
27 the low voltage secondary windings being suitable for powering the cathodes of a gas-
28 discharge lamp;
29 the high voltage secondary winding being suitable for connection across a gas-discharge
30 lamp;

1 the high voltage secondary proving sufficient voltage to ignite a gas-discharge lamp;
2 the lamp current being limited by the capacitor in series with the input terminal and the
3 primary winding;
4 the circuit arrangement resulting in a reduction of voltage across the cathodes after the
5 gas discharge lamp has ignited.

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Under-cabinet Lighting System

ABSTRACT

A low cost under-cabinet and display case lighting system that permits the highest degree of flexibility in the installation and location of luminaires for under-cabinet and display case lighting. The system consists of a high-frequency power source, an interconnection cord, and one or more high-frequency luminaires. The high-frequency power source is powered from a source of 50 or 60 Hertz power. The interconnection cord is connected to the high-frequency output of high-frequency power source. The high-frequency luminaires are mounted in the desired locations under the cabinets or display case shelves. The interconnecting cord is then routed to each of the high-frequency luminaires and placed over the input terminals. The protective cover is then forced over the interconnecting cord in the area of the input terminals forcing the input terminals to pierce and displace the insulation of the cord and make contact with the conductors within the interconnecting cord. Any number of additional high-frequency luminaires (within the capacity of the high-frequency power source) may be added in the same manner.

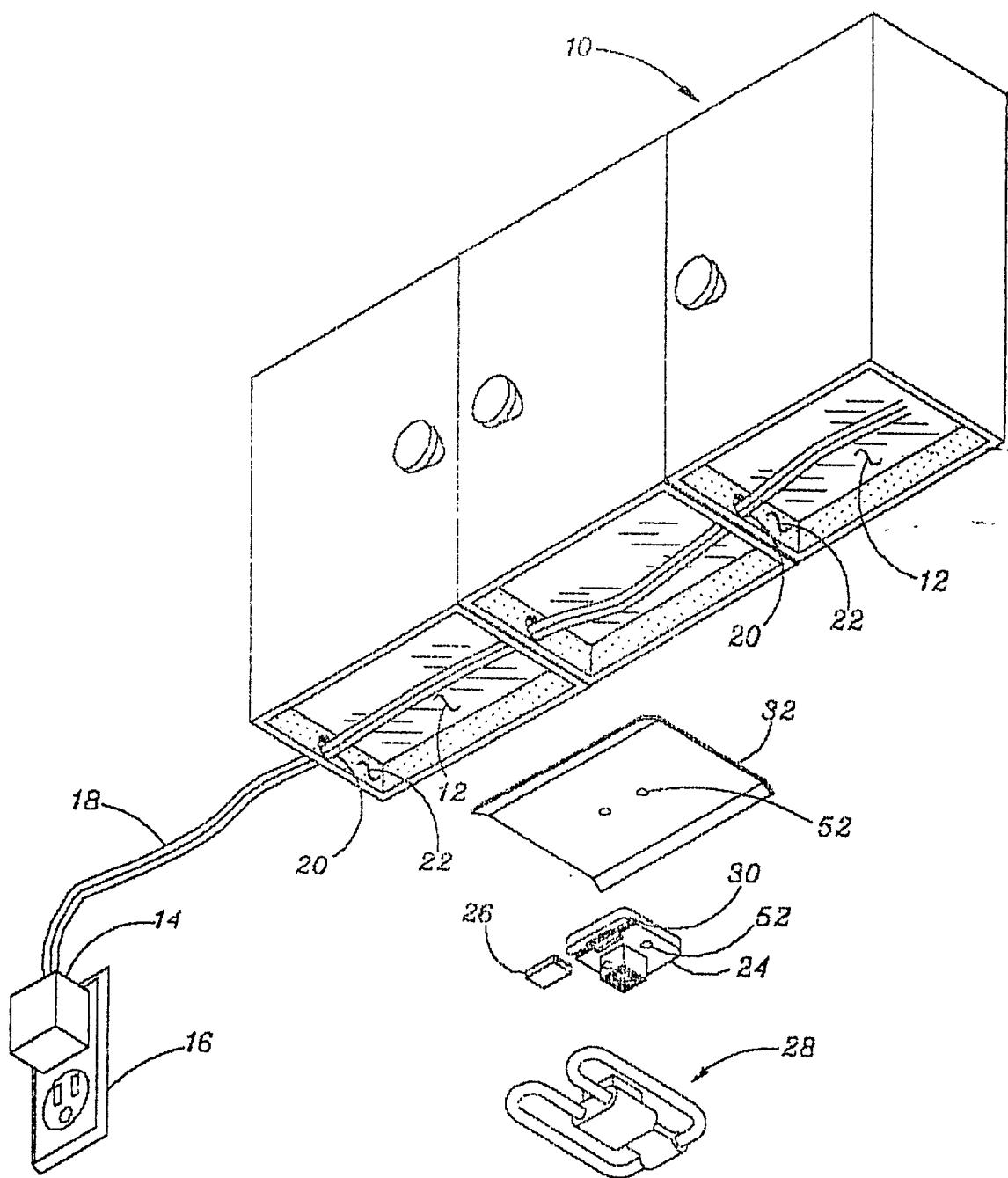
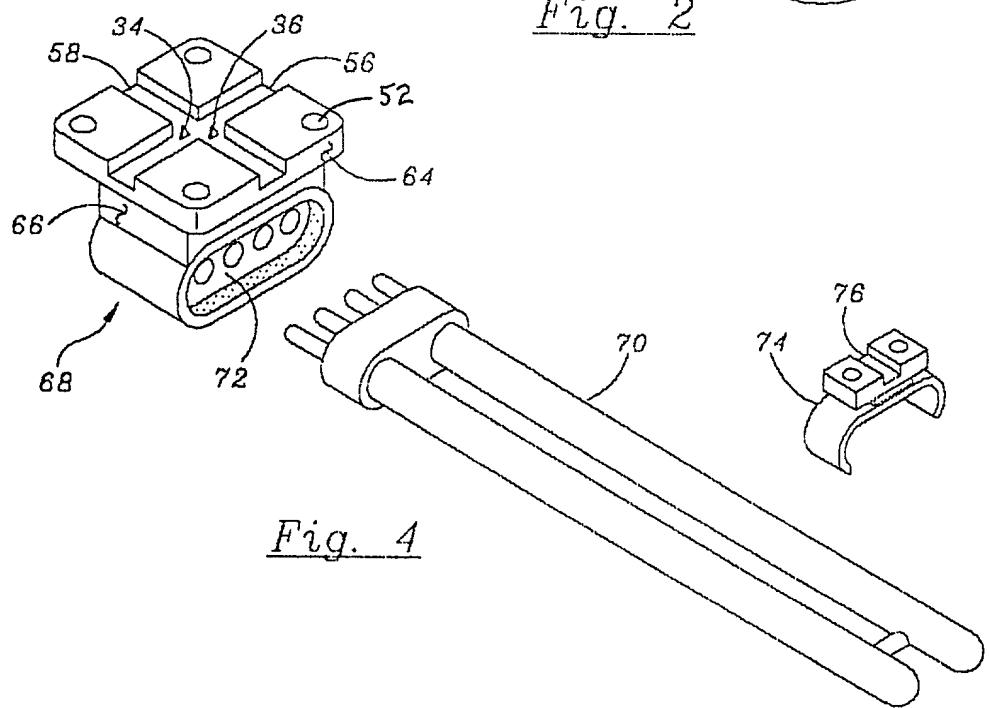
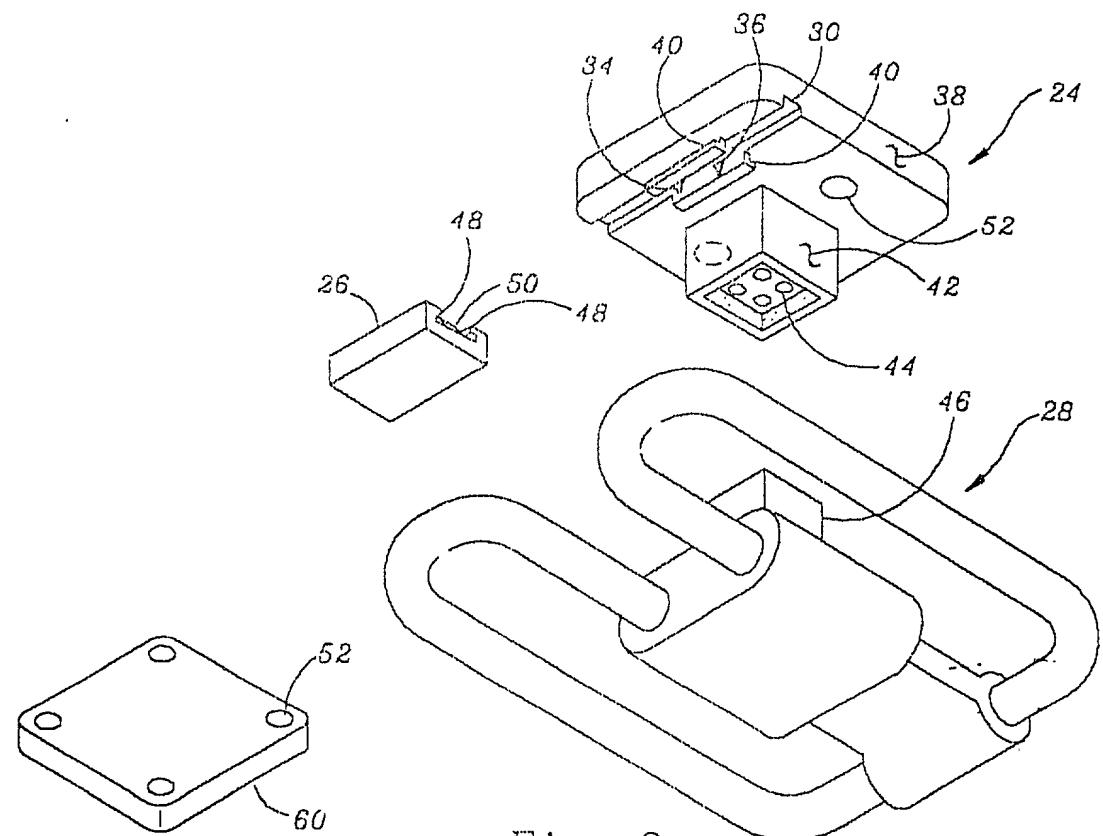


Fig. 1



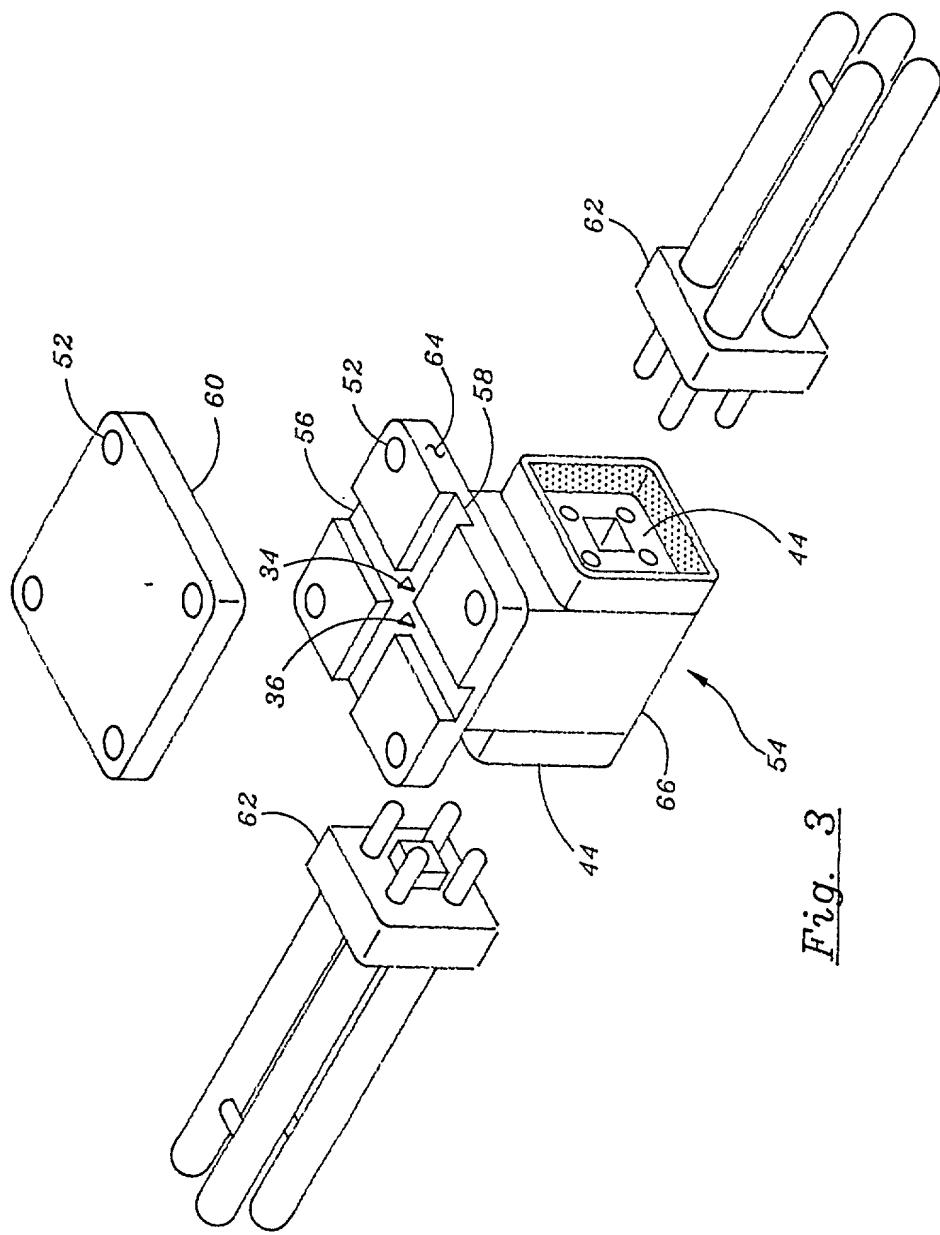


Fig. 3

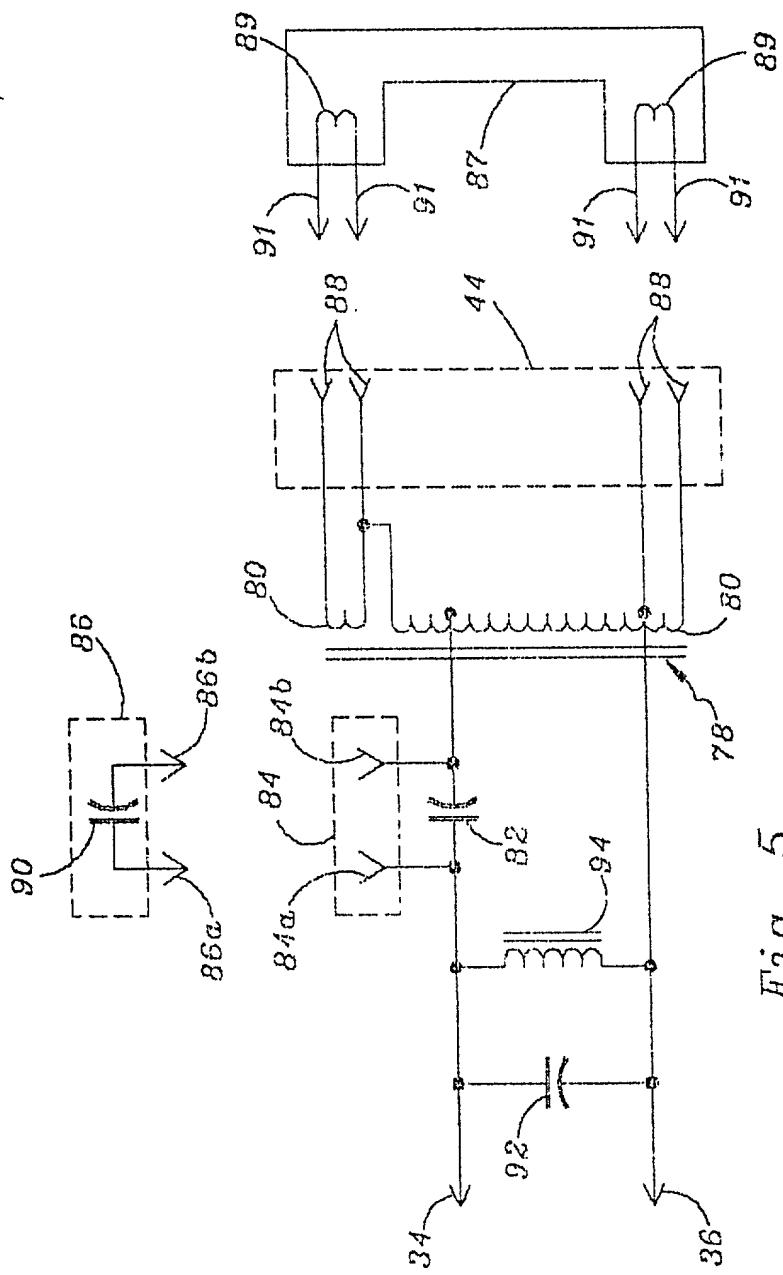


Fig. 5.

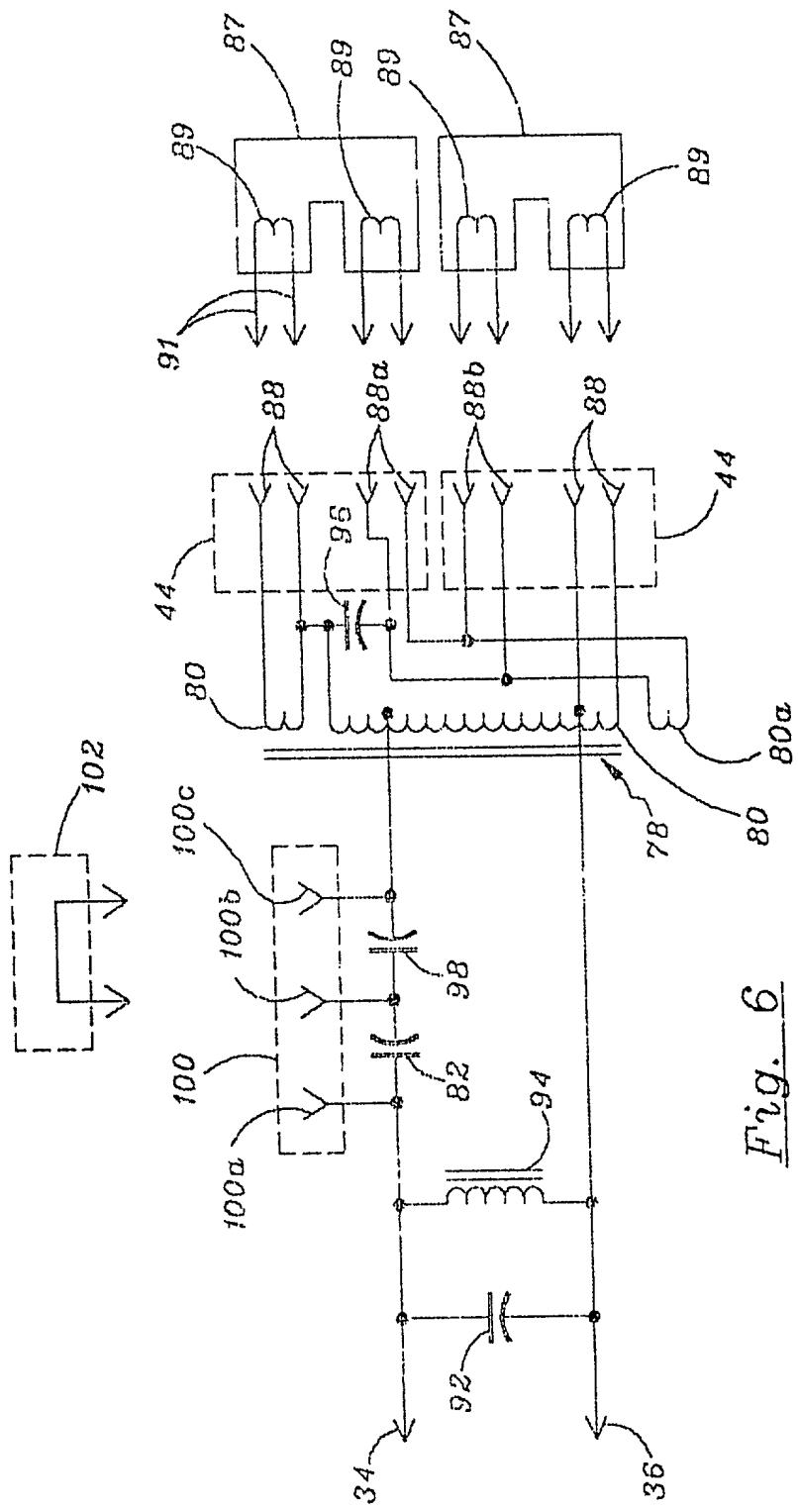


Fig. 6

Declaration for Utility or Design Patent Application

As a below-named inventor, I hereby declare that my residence, post office address, and citizenship are as stated below next to my name and that I believe that I am the original, first, and sole inventor [if only one name is listed below] or an original, first, and joint inventor [if plural names are listed below] of the subject matter which is claimed and for which a patent is sought on the invention, the specification of which is attached hereto and which has the following title:

"UNDER-CABINET LIGHTING SYSTEM"

I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment specifically referred to in the oath or declaration. I acknowledge a duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, Section 1.56(a).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Title 18, United States Code, Section 1001, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Please send correspondence and make telephone calls to the First Inventor below.

Dale E. Fiene

Signature

8/29/00

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